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## ENDEMISM IN THE FLORA OF THE VICINITY OF NEW YORK\*

BY NORMAN TAYLOR

Of the 2,038 native species in the flora near New York† twenty-two or something over one per cent. are endemic, which, as here considered, means that they are found nowhere else in the world. The endemics are as follows:‡

<i>Sporobulus Torreyanus</i>	<i>Hypericum Bissellii</i>
<i>Savastana Nashii</i>	<i>Hibiscus oculiroseus</i>
<i>Amphicarpon Amphicarpon</i>	<i>Kneiffia Allenii</i>
<i>Calamovilfa brevipilus</i>	<i>Ludwigiantha brevipes</i>
<i>Juncus caesariensis</i>	<i>Pyrola oxypetala</i>
<i>Uvularia nitida</i>	<i>Dendrium buxifolium</i>
<i>Salix squamata</i>	<i>Stachys atlantica</i>
<i>Dentaria incisifolia</i>	<i>Eupatorium resinosum</i>
<i>Dentaria anomala</i>	<i>Euthamia floribunda</i>
<i>Prunus Gravesii</i>	<i>Helianthus Dalyi</i>
<i>Prunus alleghaniensis</i>	<i>Senecio Crawfordii</i>

The causes of this endemism are very obscure; perhaps in the very nature of the case there may be a considerable element of chance in it. Some things stand out in connection with our local endemics however, that may throw light on the problem, and it seems certain that a number of related subjects should catch more or less direct illumination in the course of such a study.

It has been argued by Sinnott and Bailey that endemism is a criterion, at least to a considerable extent, of the antiquity of a flora. Their reasons for this have been so clearly and so recently set forth in the *Annals of Botany* and in the *American Journal of*

\* Contributions from the Brooklyn Botanic Garden No. 12.

† Nomenclature, and the range considered, the same as in the writer's "Flora of the Vicinity of New York: A Contribution to Plant Geography." Mem. New York Bot. Gard. 5: 1-688. 1915.

‡ It will be seen that the list differs from that in Mem. New York Bot. Gard. 5: 32, by the inclusion of *Prunus alleghaniensis* and exclusion of *Vaccinium caesariensis*. The first has been found in a few Pennsylvania counties just outside the range, the second now appears to extend south of our area.

*Botany* that only mere mention of them is necessary here. Conversely, Willis\* has argued that the endemic element in the flora of Ceylon is a criterion of its youth. He says, in fact, that the endemic element in the Ceylon flora is the youngest. Is one, or the other, or both, of these diametrically opposed statements to be discarded? Or is endemism in a flora a matter with which antiquity or youth has little or nothing to do? An answer to these questions seems to be furnished by the behavior of the endemics in the local region. A middle course, a compromise if you will, between the champions of youth and age may be not only "playing it safe," but true.

One of the points made by Bailey and Sinnott is, that on the whole, endemic species are not only the most ancient element in any given flora, but that they are also more apt to be of a woody than an herbaceous type. They came to this conclusion after an elaborate study of the problem from many angles, one of which was phytogeographic. Furthermore their contention is that of the endemic species in a flora, the species of the endemic genera would be still greater criteria of antiquity and still more apt to be woody. The facts, as illustrated in our region scarcely support either of these opinions. In the total flora of the vicinity of New York 83 per cent. of the vegetation is herbaceous† and 17 per cent. woody. Of the 22 endemic species only four, *Prunus Gravesii*, *P. alleghaniensis*, *Salix squamata*, and *Dendrium buxifolium*, are woody, which is 18.18 per cent. of the total endemic element. The percentages of woody plants among the endemics and among the total flora, are too nearly alike to support the theory that the endemic element of a flora is predominately woody, for in our area it is no more or less so than 1.2 per cent. which means nothing. In other words, the woody and herbaceous elements of the total vegetation bear essentially the same ratio, one to the other, that we find among the purely endemic species.

As to the antiquity of the endemic element in our native flora

\* Willis, J. C. The endemic flora of Ceylon with reference to geographical distribution and evolution in general. Phil. Trans. Royal Soc. London B. 206: 307-342. 1914.

† Am. Jour. Bot. 2: 23-31. 1915.

some rather suggestive facts present themselves. It would seem that the theory demands most of our endemics to occupy that part of our area, which, as supporting the oldest vegetation we have, the pine-barrens of New Jersey, has the greatest title to antiquity of any region near New York. Of the 22 endemics only 7 are found in the pine-barrens, *Sporobulus Torreyanus*, *Juncus caesariensis*, *Eupatorium resinosum*, *Dendrium buxifolium*, *Uvularia nitida*, *Calamovilfa brevipilus*, and *Amphicarpon Amphicarpon*. The balance of the endemics are found as follows: 6 on the coastal plain (not of course, in the pine-barrens), which is recent, 7 in the glaciated area to the northward, probably still more recent, and most offending of all, 2 are confined to salt marshes which are almost new enough for their origin to have been seen.

Coming now to the question of the antiquity and woodiness of the endemic species of the endemic genera, which should best illustrate the theory under consideration, it should be stated that *endemic genera* are here understood to mean those found only in America. The species of the endemic genera are:

<i>Amphicarpon Amphicarpon</i>	<i>Dendrium buxifolium</i>
<i>Calamovilfa brevipilus</i>	<i>Ludwigiantha brevipes</i>
<i>Uvularia nitida</i>	<i>Euthamia floribunda</i>
<i>Helianthus Dalyi</i>	

We should expect the woody element to predominate in this group whereas only *Dendrium* is woody, less than 15 per cent. Of the seven species, four, *Amphicarpon Amphicarpon*, *Calamovilfa brevipilus*, *Uvularia nitida* and *Dendrium buxifolium* are found in the ancient pine-barren region, the rest are scattered along the very recent coastal plain. This is scarcely overwhelming evidence for antiquity or woodiness among the species of the endemic genera.

Indeed the case for either woodiness or antiquity among either the whole group of endemics, or among the endemic species of endemic genera, seems decidedly not proven, so far as our local vegetation is concerned. The ratios in these cases are too near those of the total vegetation not to be open to great suspicion.

It may be objected that, in using such a small area, a very slender weapon has been taken with which to attack a great conception, splendidly worked out from many angles not touched on here. The obvious retort would be that part of the argument used by the authors of that conception is phytogeographic, and it is solely phytogeographic evidence in our local region that leads to the suspicion that endemism may not really be a criterion of antiquity or of woodiness at all. Many endemics may possess both these not necessarily related qualities, or only one of them, but that either woodiness or antiquity have much to do with endemism seems a very open question.

An altogether different viewpoint is that of J. C. Willis, who has argued that the endemic species in a flora are the most recent, especially if they are very local and not widespread. He would measure the antiquity of an endemic by its ability to spread, and he has shown that in the flora of Ceylon those endemics are oldest which are the commonest, and that the most recent are the endemics which have been found only once or twice, or at a few localities. "On the average the commonness of a species depends upon its age from the time of its arrival in, or evolution in, the country. The commonness of any individual species will, of course, also depend upon its degree of adaptation to local conditions, and upon many things which can only be regarded as chance, such as the sudden appearance of new factors, like disease, etc., in the problem." Upon this conception all species would start as endemics, very local in youth, becoming more widespread in middle age, and in old age either ceasing to be endemics because they become too widespread to be entitled to that name, or else, through specific senility, disease, or other cause, dying out altogether.

Our local endemics are so well known that their distribution is easily checked with these points in view. Ten of them are very rare, having been found only in one or two localities. They are as follows:

*Savastana Nashii*  
*Salix squamata*  
*Dentaria incisifolia*

*Hypericum Bissellii*  
*Pyrola oxypetala*  
*Helianthus Dalyi*

*Dentaria anomala*  
*Prunus Gravesii*

*Euthamia floribunda*  
*Ludwigiantha brevipes*

It is certainly significant that all these are found in the very recent glaciated area or on the coastal plain, not one of them in the ancient pine-barren region. This certainly agrees with Willis's conclusion that rarity and youth go hand in hand. It is also true that all the pine-barren, and therefore ancient, endemics, mentioned on page 20 are frequent or even very common in that region. Which seems to prove that commonness and age, like rarity and youth, have some relation to each other, just as Willis has argued. Evolutionary theory, and especially mutation, would also lead to the conclusion that rare endemics are recent.

A rather serious objection to this theory, however, is furnished by *Prunus alleghaniensis*, *Senecio Crawfordii*, *Kneiffia Allenii*, *Hibiscus oculiroseus*, and *Stachys atlantica*. All these are certainly not rare, and all are found in geologically the more recent part of our region, while the *Hibiscus* is a salt-marsh plant and therefore very "new." Some of these extra-pine-barren, and presumably recent endemics, have already occupied more area and become commoner than the pine-barren, and presumably ancient endemics, which is not at all what we should expect if the Willis theory were wholly true.

While our local endemics seem to fit the theory of Willis better than they do that of Sinnott and Bailey, the fit in both cases leaves much room for doubt. In both cases, too, the theories attempt to explain the results, rather than the underlying origin of endemism.

So far as our local endemics are concerned a few can be dismissed, as to their origin, by the statement that they are relict endemics. Such seems to be the case with *Ludwigiantha brevipes*, *Amphicarpon Amphicarpon*, *Calamovilfa brevipilus*, *Dendrium buxifolium*, and *Uvularia nitida*. In all except the last, the only related species are found in Florida or somewhat to the north of it, there being a considerable break in the distribution along the coast between these widely separated generic outposts. None of the first four have any relatives in the

immediate region, and are therefore to be regarded as relict endemics, which could not have arisen recently, from related species, for there are none from which they could have been derived. Evidently they are relicts of that ancient southern flora, some of which has been lost, leaving these generic outposts in our area. Although *Uvularia nitida* belongs to a genus containing two other species, within our area its nearest relative (*U. puberula*) is a plant from the southeastern United States. On this account it should, in all probability, be considered a relict endemic like the others, all of which, with it, are species of endemic genera. Only *Dendrium* is woody, although this group of endemics is to be considered the most ancient of any that are found here.

There is another group of local endemics which seems to be, and probably is, of very recent origin. They are found in genera that, so far as the local region is concerned, dwindle in numbers in their passage through the region. In the following table are given the endemics of this class, the number of local species in the genus in which they are contained, and the number of native species of that genus that reach their distribution outposts here:

Endemic Species.	Number of Local Native Species in Genera Containing Endemics.*	Number of Species Reaching Distribution Outposts in the Area.
<i>Sporobolus Torreyanus</i> . . . . .	7	2
<i>Juncus caesariensis</i> . . . . .	27	7
<i>Salix squamata</i> . . . . .	19	5
<i>Prunus alleghaniensis</i> . . . . .	7	2
<i>Hypericum Bissellii</i> . . . . .	13	3
<i>Kneiffia Allenii</i> . . . . .	5	1
<i>Eupatorium resinosum</i> . . . . .	14	3
<i>Euthamia floribunda</i> . . . . .	3	1
<i>Helianthus Dalyi</i> . . . . .	8	3
<i>Senecio Crawfordii</i> . . . . .	5	2

It would seem that to this generic instability, if it can be so called, is due the origin of the endemic species in the above list.

\* In each case less one species, the endemic one. As will be seen subsequently it is obviously improper to count the endemic species in this column. The basis of the argument is that they are derivatives of the generic content of our flora, and therefore should not be included in a count of the elements of that content. As derivatives we must exclude them from the count of the material from which they have been derived.

For it is well known that genera are more prolific of new forms at the edge than at the center of their range. A striking case in our area is that of *Panicum* and *Carex*, which both have dozens of specific outposts in the region. As it happens none of these are endemic here, but that in no way invalidates the contention, as the species may spread as in both these cases, so as not to be endemic in our particular region.

In somewhat the same category are those endemics which while they do not belong to genera that dwindle in our region, are related to species that find their distribution outposts here or very near here. Such are *Dentaria incisifolia* (related to *D. maxima*), *Hibiscus oculiroseus* (related to *H. Moscheutos*), *Stachys atlantica* (related to *S. hyssopifolia*), and *Pyrola oxypetala* (related to *P. chlorantha*).

Here again, as in the endemics that are found in the dwindling genera, it is the element of instability, which seems to be the underlying cause of the production of new forms. There may have been thousands of such forms produced in our area but only a few have been detected. Some of these are already widespread, but it does not seem clear that they are therefore, as Willis would have us believe, the most ancient of the endemic element. For the speed with which the endemic *spreads* may have little or nothing to do with the cause of its origin. So many factors enter into the *distribution* of an endemic, that it seems scarcely safe to take this as a criterion of its age in any given area. Other things being equal, we should expect to find our newest endemics the most restricted, and *vice versa*. But other things are not equal, indeed the inequality of other things, is, as we have seen, so great that such a criterion of antiquity in endemism must be used with extreme caution.

In the whole native flora of the region about 20 per cent. of the species reach their distribution outposts within the area. Excluding the relict endemics, noted above, all the rest of our endemics except three to be treated presently, belong to genera that dwindle, or are related to species that are on or near their outposts, in this region. The inference that generic and specific instability is the chief factor in the origination of these endemics



seems unescapable. It cannot be without significance that so many of our endemics are in genera, or are related to species which, if the phrase be permitted, appear to flutter along the edge of things. This generic and specific waywardness is forcibly impressed on us by the dropping out of species as the genus diminishes through the area, or by the number of species related to endemics, which find their outposts here or very near here.

Excluding the species of the endemic genera, which are as we have seen, nearly all relict endemics, it proves interesting to see what relation our eastern American proportion of species in each genus containing endemics, bears to the distribution of the whole genus. The following table gives these figures, for all the endemics except species of endemic genera and three others which will be considered presently.

	Native Species in E. N. America	Total New World Species	Total Old World Species
<i>Sporobulus</i> .....	19	40	43
<i>Juncus</i> .....	47	60	103
<i>Salix</i> .....	39	47	196
<i>Prunus</i> .....	8	31	86
<i>Dentaria</i> .....	6	6 or 7	10
<i>Hibiscus</i> .....	5	63	200
<i>Hypericum</i> .....	21	82	166
<i>Kneiffia</i> .....	8	12	3 (?)
<i>Pyrola</i> .....	8	13	7
<i>Stachys</i> .....	11	16	150
<i>Eupatorium</i> .....	21	130	265
<i>Senecio</i> .....	20	500*	535

As throwing a broader light on this question of the production of endemics far from the center of distribution of a genus, it is not without significance that in only three cases, in the table above, does the region in eastern North America seem to be anywhere near the generic center. In *Kneiffia*, which may be all American, as there is some doubt as to the Old World species being correctly credited to the genus; and in *Pyrola* and *Dentaria*, which are nearly all of the North Temperate Zone and almost impossible of generic centralization, we have the only exceptions. It would seem as though these three were not enough to upset the main contention of this paper which is that endemism is most likely to occur at or near the periphery of generic distribu-

\* Nearly all tropical.

tion rather than near the center. Certainly nearly all our local evidence points that way, and on a much wider scale, the distribution of the genera which happen to contain local endemics, further supports the argument. If this is correct, it will be seen that endemism may have little to do with woodiness or antiquity; indeed, as we have seen, it does not seem to bear much relation to either of these qualities in our local area. Nor may it have much to do, either, with rarity or commonness, for it has also been shown that these questions relate to the subsequent performance of endemics rather than to their origin. The powers of adaptation, which must be the measure of the capacity to spread, differ so widely and are influenced by so many factors with which endemism has confessedly nothing to do, that the use of the rarity or commonness of any particular endemic as a criterion of its age is likely to lead to grave error.

There are still three more endemic species in the local flora area that have not been accounted for. In some ways they are the most puzzling cases of the lot, for they do not seem to be in the category of their fellows. In the case of two of them they might be called "habitat endemics." *Prunus Gravesii* is obviously a rock-loving offshoot of the predominately sand-inhabiting and widely dispersed *P. maritima*. This curious form has only been found at one locality, on a rocky ledge, where the difference between its habitat and that of its probable progenitor is very marked. The other habitat endemic is *Savastana Nashii*, which is the only salt-marsh species of the genus known in the area. The inference that it has been derived from the closely related *S. odorata* is obvious. In fact there are taxonomists that doubt the specific validity of this endemic at all. About the third and last of our local endemics little is known, either of its origin or of the causes of that origin. There seems, in this case, so little collateral evidence that one is almost glad to record merely its name, *Dentaria anomala*!

#### SUMMARY.

Endemism, as found in the flora of the vicinity of New York, does not appear to be a criterion of antiquity, for many endemics are very recent. Neither are the endemics prevailingly woody,

for the occurrence of only four woody forms out of a total endemic element of 22 species, disproves this contention. Nor do antiquity or woodiness prevail among the species of endemic genera.

Rarity or commonness do not appear to have much to do with the age of our local endemics. For it has been shown that some of our most widely spread species are among the newest in point of origin. Speed of distribution, may be, and usually is, controlled by factors with which the origin of an endemic has nothing to do.

Relict endemism accounts for five of the local species which are shown to be outpost survivals of a preëxisting flora. All of these are species of endemic genera; only one is woody although these are probably the most ancient of all our endemics.

Generic and specific instability seems to account for the great majority of our endemics, 14, in all. These species are all shown to belong to genera that dwindle, or to be related to species, that are on or near their limits, in the local region. Further support of this view is given by the proportion of species in eastern North American genera containing endemics, to the number of species found in the rest of the country and abroad. It was also shown that while only 20 per cent. of our whole vegetation finds its limits in the area, much over half of our total endemics belong to genera that dwindle, or are related to species that find their limits, here or very near here.

"Habitat endemism," where a species seems to have been thrust off from a well known and widely dispersed form, into a totally different habitat from that of the supposed progenitor, seems to account for two of our local endemics. And one other is anomalous.

Endemism seems, then, to be a quality in the making of which many forces are operative. It may not always be possible to say as to just what is to be attributed the origin and successful spreading of any particular endemic. The various tendencies, outlined above, seem to shape themselves from a study of the local species, but it may be found that the principles here set forth must be modified when they are applied to other and wider fields.